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ABSTRACT

This study attempts to investigate development of expertise in the area of economics. Results suggest that development of expertise in economics has a stage-like development similar to the domain of medicine. Studies in medicine show that expertise development is not simply a process of extending knowledge in existing semantic networks. The study involved 7 experts from the economics department, 8 fourth-year university students, and 10 novices at the end of the first year of the economics programs. Subjects were given a text for a limited period of time and then asked to write down as much as they could remember after the time lapsed. The cases examined were considered to be at intermediate difficulty. Recall and case analysis protocols were scored against the original case text propositions. Data suggest a stage of development among novices, intermediates, and experts. (EH)

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Expertise in economics: recall and reasoning

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Abstract

In many areas where problem-solving expertise has been studied, consistent patterns of change in problem-solving have been found as expertise increases . Studies in the domain of medicine have shown that expertise development is not simply a process of extending knowledge in existing semantic networks. Although the intermediate effect in medicine appears to be very consistent, it seems that nearly no comparable studies exist in other knowledge domains. The present study attempts to investigate development of expertise in the area of economics. The results suggest that development of expertise in economics has a stagelike nature that is comparable to what has been found in medicine.

Introduction

In many areas where problem-solving expertise has been studied, consistent patterns of change in problem-solving have been found as expertise increases (Glaser & Chi, 1988). Experts are faster, more efficient, and more reflective because of the nature of their knowledge-base and acquired general problem-solving skills. Beginners construct solution paths, working backward from the goal to solve a problem. By contrast, experts move forward from the problem to the goal. It seems that experts are more efficient at searching a particular solution or finding a correct diagnosis because of different problem representations (Ericson & Smith, 1991). Novices tend to organize their representation around the surface structure of the problems. Knowledge of novices is organized around literal objects explicitly given in a problem statement. This is in sharp contrast with experts' knowledge. This knowledge is organized around principles and abstractions that subsume these objects. These principles are not explicitly stated in a problem, but only implied by problem statements.

It is generally assumed that knowledge is structured in networks of related concepts, referred to as semantic networks (Bruer, 1993). As learning occurs, new information is coupled to existing networks. Depending on how this is done by learners, new information may be effortlessly retrieved and used to solve problems, recognize situations, or recall factual knowledge. Semantic networks are not only a way of storing information; they also influence how information is interpreted, recalled and used in problem-solving situations. It seems that experts recognize problem situations as an instance of a certain problem type (Bryson, Bereiter, Scardamalia & Joram, 1991). This enables them to apply previously learned procedures appropriate to the problem-type. Novices neither possess a great deal of experts' knowledge nor the problem-solving skills in conjunction with the knowledge base required.

Studies in the domain of medicine have shown that expertise development is not simply a process of extending knowledge in existing semantic networks (Schmidt,

Norman & Boshuizen, 1990; Patel & Groen, 1991; Schmidt & Boshuizen, 1993). Size of semantic networks is not linearly related to expertise development. But, the relationship between expertise and features of semantic networks is far more complex. It appears that one of the most consistent findings in novice-expert comparisons conducted in the area of medicine, is the so-called intermediate effect. Expert physicians typically recall fewer propositions than do intermediate medical students who recall more than novices (Schmidt & Boshuizen, 1993). This phenomenon is defined as the so-called intermediate effect in clinical case representation studies. Patel and Groen (1991), and Schmidt, Norman and Boshuizen (1990) have developed theories of expertise that try to explain this phenomenon by formulating stage theories of expertise development. For example, Schmidt, et al (1990) propose a model of cognitive development in which expertise is not so much a matter of superior reasoning skills or in-depth knowledge. But expertise development is a matter of moving through several transitory stages, characterized by distinctively different knowledge structures underlying their performance. Patel and Groen (1991) argue that intermediates conduct many irrelevant searches during case processing, whereas experts do not. Novices do not conduct these irrelevant searches, because they do not have a knowledge base to search.

Although the intermediate effect in medicine appears to be very consistent, it seems that nearly no comparable studies exist in other knowledge domains. Patel and Groen (1991) argue that medicine is actually a rather peculiar domain. For example, in medicine a marked difference exists between basic sciences and applied sciences. An obvious question is whether these findings in medicine are generalizable to other domains. For example, Voss and Post (1991) state that only limited agreement may exist, if any, among experts in economics about underlying principles, mechanisms or laws. It seems clear that studies are needed in different areas with different structures of knowledge bases and typical problem-situations (e.g. Patel & Groen, 1991; Bryson, Bereiter, Scardamalia & Joram, 1991).

The present study attempts to investigate development of expertise in the area of economics. The aim of this study is to examine whether the findings by Patel and Groen (1991), and Schmidt, Norman and Boshuizen (1993) can be generalized to the economics domain that by its very nature substantially differs from medicine. The expert-novice paradigm was used to assess amount of recall, diagnostic accuracy and patterns of reasoning in two typical economics cases.

Method

Subjects. We asked 7 experts (professors, having more than 10 post-graduate years experience) from the economics department, 8 intermediates (fourth year university students, a few months before graduation), and 10 novices (end of first year university students following the economics program). Subjects received a small compensation for their participation.

Procedure. A standard experimental procedure for expert-novice studies was followed (Patel & Groen, 1991). Subjects were informed that after they got a text for a limited period of time, they would be asked to write down as much as possible as they could remember. After this assignment, they would also be asked to analyse and diagnose the case. Each subject was shown a written description of an economics case. First, they were asked to read carefully the case text for one minute, after which the text was removed. Second, after removing the text they wrote down as much as possible they could remember. Third, they had to provide a written analysis about the economical situation presented in the case in terms of underlying processes. Finally, a diagnosis about the situation was required.

Materials. The materials consisted of two economics cases (each a 200 word case description and for each case two blank response sheets). The cases were considered to be at the level of intermediate difficulty (between end of year one and begin of year 4). Case A is about a country that at first sight is doing well (very low

unemployment, economic growth is good, steady increases in production and consumption) but is also showing some minor signs of a possible shift in economic trend. Case B is about a country that has clear marked economics problems (high unemployment, sharp decrease in national income, high costs for wages), but it is unclear how long this situation will continue for worsening or whether at some point a positive shift may be expected. Appendix 1 contains the full text of the assignments.

Analysis. The case texts were segmented in propositions. Propositions consisted of two concepts connected by a qualifier (Kintsch, 1974). Both recall and case analysis protocols were scored against the original case text propositions. Recall protocols were scored on the count of literal reproductions of the text. Propositions in the recall protocols were classified as case-relevant or case-irrelevant, based on experts' classification. Case analysis protocols were scored by counting the number of recalls, inferences, economics principles, and diagnoses. Transformations made on the original text were called inferences. If subjects showed to use knowledge characterized as typical "principles" knowledge (for example, "According to Philips Curve the relation between inflation and unemployment develops like ..") then this was scored as "principles".

Results and Discussion

Free recall. Figure 1 shows the mean percentages of propositions recalled by the subjects in the free-recall protocols. Both the results of case A and case B are included in figure 1. Novices recalled in both cases significantly fewer information than intermediates and experts. However, overall differences between level of expertise were only statistically significant for Case A [$F(2,22) = 5.86$, $MS_e = 3.677$, $p < .01$] and not significant for Case B [$F(2,22) = .77$, $MS_e = 9.345$, $p < .50$]. Figure 2 gives the mean percentages of relevant and non relevant information recalled by the three groups subjects.

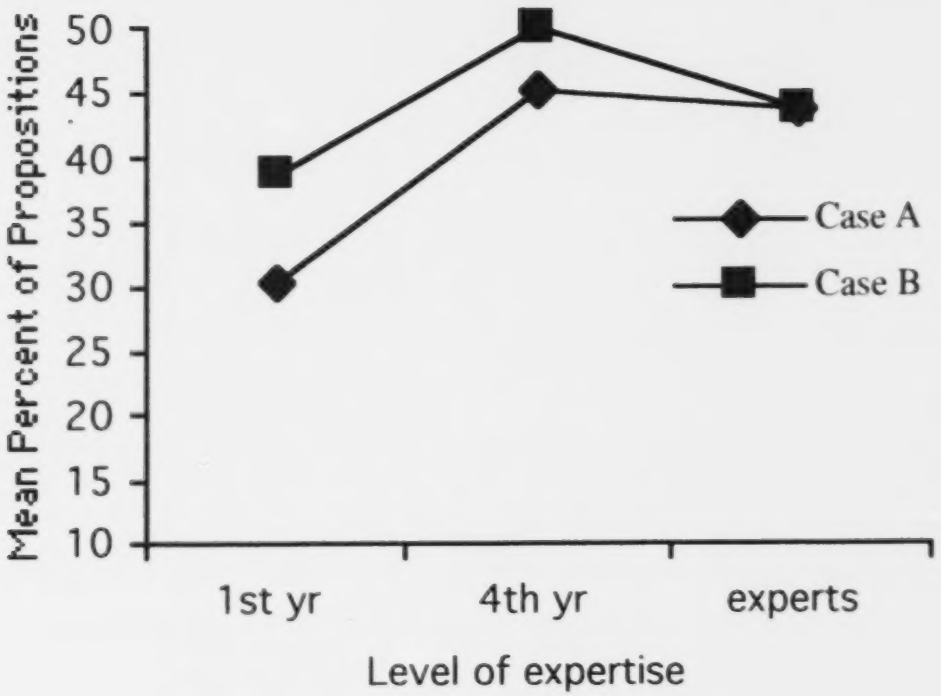

Figure 1. *Mean percentages of propositions recalled from case A & B as a function of expertise.*

A significant two-way interaction effect in Case A was found for Level of Expertise and Relevant Information [$F(2,51) = 2.89$, $MS_e = .072$, $p < .06$], while none of the main effects were significant. This implies that experts recall significantly more relevant information than non relevant information, while novices and intermediates recall nearly equal amounts of relevant and irrelevant information. For Case B no significant interaction or main effects were found.

Diagnostic accuracy. A statistically significant main effect of level of expertise was found for diagnostic accuracy for Case A [$F(2,22) = 17.347$, $MS_e = .385$, $p < .0001$] and for Case B [$F(2,22) = 5.991$, $MS_e = .765$, $p < .01$]. Experts provided for both cases more accurate diagnoses than intermediates and novices.

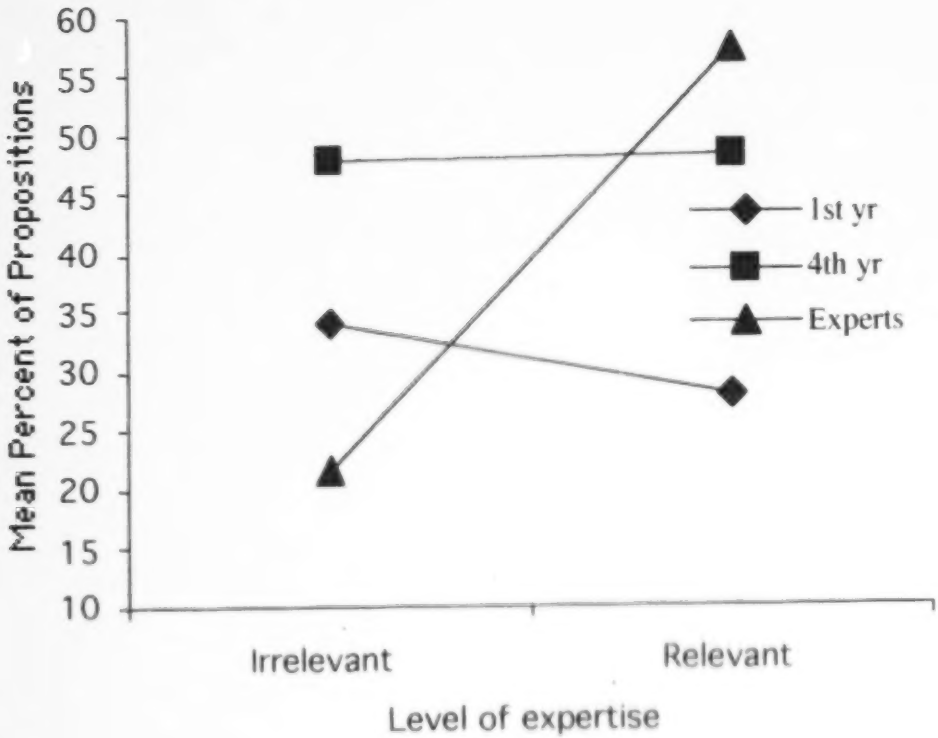

Figure 2. *Mean percentages of propositions recalled by level of expertise and relevance of information.*

Analyses of the kind of diagnoses provided indicate that experts identify both the causes of the economic situation in the case and what kind of policy is required in this situation. Contrarily, the intermediates' diagnoses remained restricted to identifying causes, not knowing what policy should be followed. The majority of the novices could provide neither of the alternatives.

Reasoning. Next to assessing diagnostic accuracy, the reasoning process in the case explanations were analysed. Counts of factual recall, principles from economics, and inferences upon facts were computed. It was assumed that as knowledge bases get more elaborated and structured, a shift may be expected from backward reasoning to forward reasoning. Another expectancy was that more experienced subjects would recognize the cases as typical for certain categories of problem situations in economics.

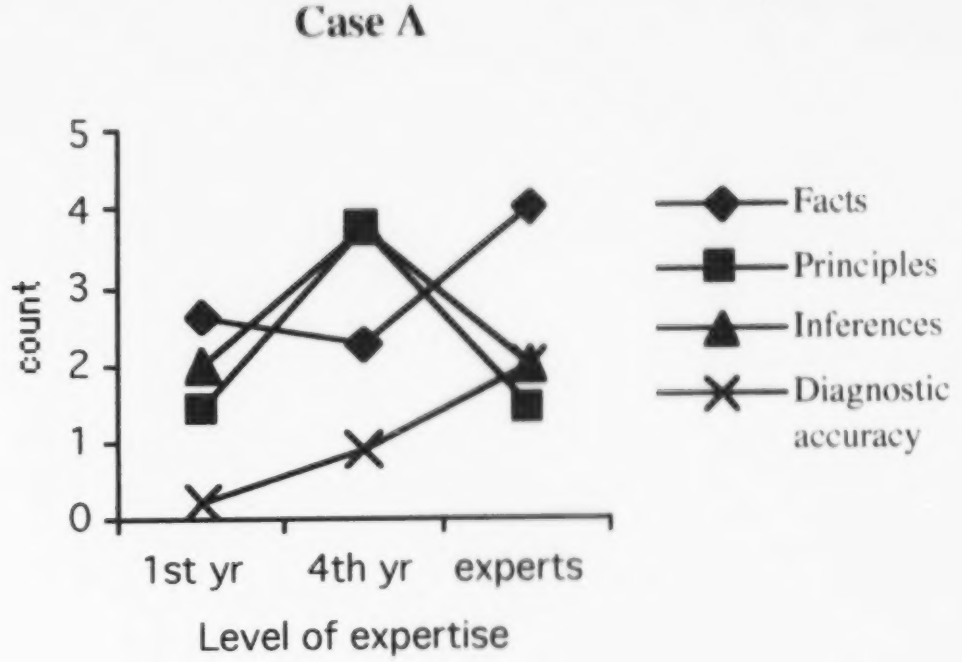

Figure 3. *Number of facts, principles, inferences and diagnostic accuracy in explanation protocols as function of expertise.*

Figure 3 shows the counts for diagnostic accuracy, factual recall, principles from economics, and inferences produced in the explanation protocols of Case A. A statistically significant effect ($p < .10$) of expertise was found for all measures except one (recall of facts). Case B shows a comparable pattern.

The data in figure 3 indicate that students and experts represent economics cases in different ways. First year students use significantly less procedural knowledge (principles and inferences) than fourth year students.

By contrast, experts activate a set of facts and only a few principles/inferences resulting in accurate diagnoses. Fourth year students show behavior that may be interpreted as typical intermediate behavior. The processing of the case results in the activation of a rich knowledge base of procedures and rules, but not instantaneously recognizing the situation. Qualitative analyses of their diagnoses shows that fourth year

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students provide diagnoses that can be qualified as accurate descriptions of the situation, but not indicating how to proceed in this situation.

The data suggest that development of expertise in economics has a stagelike nature because of the distinctions between novices, intermediates and experts. Further research is needed to explore the domain of economics and to test the generalizability of the theories proposed by authors like Patel and Groen (1991) and Schmidt et al (1990, 1993).

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Appendix 1

General introduction to the assignments

You are working on the Ministry of Economics as consultant. Your main job is address issues concerning the development of the Dutch economy. Now, you are getting a particular assignment. You are required to advise about the development of an economy which is totally unknown to you: the country of Utopia. The borders of this country are completely closed and has no contact whatsoever with other countries, now and in the past. The next page contains a description of the economic situation from the first visitor to Utopia. This is the only information available.

Please write down your name:

In a few moments you will get 60 seconds reading time. Don't turn down to the other pages, unless we ask you. Once you have read the information and you are working on the assignment, you are <u>not</u> allowed to turn back to the original information.

Case A

Utopia is a democratic country. Labour unions play an important role, but fair negotiations are possible. The federal bank is formally independent from the government, but in practice it is influenced by political views on economy. During the past period unemployment rate is, from a historic point of view, very low. Economics growth looks well. Over the past few years, national production has increased with about 4%. Labour productivity is increased tremendously. In many companies stocks are increasing a little. Also delivery time of machines, which was during a long time very high, has at last been slowing down. The continuous growth of consumption of 4% every year looks reasonably stable. Inflation changed from 3% to 20%. This is regarded by everyone as a major concern. Prices of the investment goods increased more than prices of consumption goods. Since the last ten years, costs of wages have grown more than costs of labour productivity. Employers and producers complain about low profits. Nominal interest changed six months ago from 15% to 30%.

Assignment 1 (new page). Write as many things as you can recall from the text on the last page (you are not allowed to turn back to the case description!).

Assignment 2 (new page). Analyse in your own words the economic situation of Utopia (you are not allowed to turn back to the case description!)

Case B

Utopia is a democratic country. Labour unions play an important role, but fair negotiations are possible. The federal bank is formally independent from the government, but in practice it is influenced by political views on economy. During the last three years, unemployment rates have changed from 3% to 16%. Investments have been cut down with 50%, during the same time the national income decreased with 35% against market prices. Most companies have large amounts of unsold stocks. Prices dropped with 20%. This is considered by everyone as a major problem. Prices of machines dropped with 50% during the last three years. Because the costs of wages dropped less than prices, the wages for workers are a big concern. Employers complain about low profits because of low production rates of their machines and because of high wages. It is only a small comfort that interest rates dropped over the past three years from 4.5% to 2%.

Assignment 1 (new page). Write as many things as you can recall from the text on the last page (you are not allowed to turn back to the case description!).

Assignment 2 (new page). Analyse in your own words the economic situation of Utopia (you are not allowed to turn back to the case description!)

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